의학석사 학위논문

Hemodynamic effects of hyperbaric bupivacaine versus isobaric bupivacaine for spinal anesthesia during cesarean delivery

제왕절개술을 위한 척추마취 시 Hyperbaric bupivacaine 과 Isobaric bupivacaine 을 사용하는 것이 혈역학적 안정성에 미치는 영향의 차이

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구 창 훈

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Department of Clinical Medical Sciences

Seoul National University College of Medicine

Chang-Hoon Koo

ABSTRACT

Introduction: Hyperbaric bupivacaine is widely used for spinal anesthesia during cesarean section. Hypotension is one of the most common complications after spinal block; thus, a continuous infusion of phenylephrine is frequently used to prevent maternal hypotension. Isobaric bupivacaine is reported to maintain stable hemodynamics more than hyperbaric bupivacaine during spinal anesthesia. Therefore, the purpose of this study is to demonstrate that isobaric bupivacaine could maintain hemodynamics without intravenous phenylephrine infusion.

Methods: This study is a prospective, double-blind and single-center trial. Sixty-six patients undergoing elective cesarean section under spinal anesthesia were randomized into one of four groups receiving 10 mg of hyperbaric bupivacaine or isobaric bupivacaine with or without a phenylephrine infusion (0.4 μg/kg/min). Before the induction of anesthesia, baseline systolic blood pressure (SBP) was calculated from three consecutive measurements. After the intrathecal injection, SBP was measured every 1 min until placenta was expelled and every 2.5 min till end of surgery. Hypotension was defined as a decrease in SBP by more than 20% of the baseline value and treated by

administering a 100 μg bolus of phenylephrine. We recorded SBP 10, 20, and 30 min after intrathecal injection and the incidence of hypotension for 30 min after spinal anesthesia.

Results: SBP at 30 min in the hyperbaric bupivacaine group without phenylephrine (HS) was lower than that in the isobaric bupivacaine group with (IP) or without phenylephrine (IS) (102.43 ± 4.14 vs 119 ± 4.20 and 119 ± 4.09, p = 0.005 and 0.005, respectively). Patients in the HS group experienced hypotension more often than those in IP group for 10 min after spinal anesthesia had been induced (88.2% vs 43.8%, p=0.007). There was no difference in the incidence of hypotension between HP group and IS group (50.0% vs 47.1%). No differences in quality of anesthesia, side effects of spinal anesthesia, or neonatal outcomes were observed among the four groups.

Conclusion: Intrathecal isobaric bupivacaine maintained stable hemodynamics when compared to intrathecal hyperbaric bupivacaine without infusing phenylephrine.

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Keywords: hyperbaric bupivacaine; isobaric bupivacaine; cesarean section; hypotension; phenylephrine

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INTRODUCTION

Spinal anesthesia is widely performed for cesarean section due to its advantages such as simplicity, rapid onset, low complication rates, and cost effectiveness.[1, 2] However, hypotension is one of the most frequent complications of spinal anesthesia, with an incidence up to 74.1%.[3, 4] Hypotension induced by spinal anesthesia is associated with the maternal risk for nausea, vomiting, and unconsciousness as well as with the neonatal consequences of fetal acidosis and hypoxia.[4] Therefore, many studies have suggested various techniques to prevent maternal hypotension, including fluid loading,[5] leg wrapping,[6] and prophylactic infusion of a vasopressor.[7]

Phenylephrine is recommended as first line therapy during cesarean delivery due to its lower incidence of fetal acidosis than when ephedrine was used as first line therapy.[8, 9] Many studies have suggested that prophylactic infusion of phenylephrine prevents maternal hypotension.[7, 10] In most studies, intrathecal hyperbaric bupivacaine was injected, but the effectiveness of phenylephrine with intrathecal isobaric bupivacaine has rarely been evaluated. Adding glucose to the anesthetics solution results in different baricity, which affects diffusion and distribution within the subarachnoid space. Hemodynamic stability is related to the spread of bupivacaine.[11] Several studies have suggested that intraoperative hypotension is more common in patients who receive

hyperbaric bupivacaine than in those who receive isobaric bupivacaine because hyperbaric bupivacaine is distributed to more cephalic segments.[12, 13] Therefore, we hypothesized that isobaric bupivacaine would maintain more stable hemodynamics without an intravenous infusion of phenylephrine than hyperbaric bupivacaine.

METHODS

This randomized clinical trial was performed from September 2015 to August 2016 at Seoul National University Hospital. The protocol was approved by the institutional review board of Seoul National University Hospital, Seoul, South Korea on September 8, 2015. The study protocol was registered at ClinicalTrials.gov (NCT02802683). All patients enrolled in the study provided written informed consent before inclusion. A total of 72 American Society of Anesthesiologists classification I–II patients aged 19–45 years and scheduled to undergo elective cesarean section were enrolled in this study. Exclusion criteria were pre-eclampsia, heart disease, fetal distress, or refusal to participate in the study. Eligible patients were assigned randomly to one of four groups: hyperbaric bupivacaine with (HP) or without (HS) intravenous infusion of phenylephrine and isobaric bupivacaine with (IP) or without (IS) intravenous infusion of phenylephrine. The randomization sequence was generated by computer using a random block size of 4. The group assignments of the patients were kept in sequentially numbered, sealed envelopes. All patients, investigators, and statisticians were blinded to allocation until all data analyses were complete.

No patient received premedication. Patients were transferred to the operating room, and standard monitoring, including electrocardiography, pulse

oximetry, and non-invasive blood pressure monitoring, was applied. Before the induction of anesthesia, blood pressure (BP) and heart rate (HR) were measured non-invasively every minute with the patient in a supine position. Baseline systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure (MBP), and HR were calculated from three consecutive measurements. After pre-hydration with 500 ml of hydroxyethyl starch (6% HES 130/0.4), spinal anesthesia was induced at the L3–L4 or L4–L5 interspace using a 25G Quincke point needle with the patient in the right lateral decubitus position. According to the assigned group, 10 mg of hyperbaric bupivacaine (Marcaine Heavy®; AstraZeneca, Luton, UK) or 10 mg of isobaric bupivacaine (Levobupivacaine: Chirocaine®; Korea Abbive, Seoul, South Korea) was injected with 10 μg of fentanyl. Immediately after the intrathecal injection, the patients were turned supine with a right pelvic wedge. Phenylephrine or normal saline was infused continuously at 0.4 μg/kg/min by a syringe pump based on the assigned group. All medications (hyperbaric bupivacaine, isobaric bupivacaine, and phenylephrine) were prepared by a nurse who was not involved in the study. The anesthesiologist and patients were blinded to the medications.

After the intrathecal injection, hemodynamic parameters such as SBP, DBP, and MBP were recorded every minute until the placenta was expelled and were then measured every 2.5 min. We defined hypotension as a decrease in

SBP > 20% of the baseline value. Hypotension was treated by administering a 100 μg bolus of phenylephrine. The phenylephrine infusion was stopped when SBP increased more > 20% of baseline. We compared SBP at 10, 20, and 30 min after spinal anesthesia had been induced and the number of interventions to treat hypotension during the 30 min after spinal anesthesia had been induced. We calculated the total dose of phenylephrine which was administered by infusion or bolus during the 30 min after the spinal anesthesia. The sensory level of anesthesia was assessed every minute with an alcohol swab. We recorded the time to reach T4 sensory block, which is defined as the onset time of spinal anesthesia. If the patient required supplemental analgesia for pain during the operation, they were given an intravenous bolus of 50 μg of fentanyl as rescue treatment. The degree of motor block was estimated using the modified Bromage scale (I = unable to move feet or knees, II = able to move feet only, III = able to move knees, and IV = total extension and flexion of knees and feet) at 20 min after the intrathecal injection. We also recorded the adverse events of spinal anesthesia, such as nausea, vomiting, headache, and request for supplemental analgesia. Apgar scores were evaluated at 1 and 5 min after delivery by a pediatric nurse. We collected umbilical arterial blood samples and measured blood gases. The motor block assessment using the modified Bromage scale was performed at 120 min after admission to post-anesthesia care unit.

The primary outcome was SBP during the 30 min after the intrathecal injection. Secondary outcomes were the incidence of hypotension, total doses of phenylephrine which was administered by infusion or bolus, onset of sensory block, highest level of sensory block, degree of motor block, complications associated with anesthesia, Apgar score and umbilical arterial gases.

According to a previous study, we considered that a 15 mmHg difference in SBP between the groups was clinically significant.[14] Therefore, we calculated that each group required 16 patients to detect a difference with a type I error of 0.05 and 80% power. We included 18 patients in each group to allow for a 10% dropout rate. Serial changes in the hemodynamic parameters were analyzed by repeated-measures one-way analysis of variance (ANOVA) followed by Bonferroni's multiple comparison post-test, with the baseline value as the covariate. Continuous variables were analyzed using one-way ANOVA or the Kruskal–Wallis test depending on whether the data were normally distributed. Categorical variables, such as the number of interventions to treat hypotension, were compared by the χ^2 test. A P value < 0.05 was considered significant.

RESULTS

In total, 72 patients scheduled for cesarean section under spinal anesthesia were assigned to one of the four groups. Two patients withdrew from the study due to an inclusion error (low gestational age), and one patient was excluded because of a drug preparation error. Three patients required an additional intervention because of failed spinal anesthesia. Finally, 66 patients were included in the analysis (Fig. 1). Demographic characteristics, duration of the operation and duration of the anesthesia were similar among the groups (Table 1).

Serial changes in SBP were analyzed with the baseline value as the covariate (Fig 2). A significant difference was detected in SBP during the 30 min after spinal anesthesia had been induced (Repeated measures of ANOVA, p=0.02). Among the three measuring points, SBP at 30 min after spinal anesthesia had been induced was significantly different between the groups (analysis of covariance, p=0.015). SBP at 30 min in the IP and IS groups was higher than that in the HS group (Bonferroni multiple comparison test, p=0.005, 0.005, respectively). Mean SBP at 30 min was 102 mmHg [95% confidence interval (CI), 94–110 mmHg] in HN group, 119 mmHg (95% CI, 111–127 mmHg) in IP group, and 119 mmHg (95% CI, 111–127 mmHg) in the IN group. There were no differences in SBP at other time points among the groups.

However, there were significant differences in the incidence of hypotension among the groups for 10 min after spinal anesthesia (Table 2). Patients in the HN group experienced hypotension more than those in IP group for 10 min after spinal anesthesia (88.2% vs 43.8%, p=0.007). However, there were no differences in the incidence of hypotension for 30 min after spinal anesthesia among the four groups. The number of interventions in each patient for treating hypotension was also similar among the four groups until 30 min after the spinal block had been induced. Patients in infusion groups (HP, IP) received more phenylephrine than those in control groups (HS, IS) (P<0.0001).

No difference in onset time was observed among the four groups or between hyperbaric bupivacaine (HP+HS) and isobaric bupivacaine (IP+IS) (5 vs 4.5 min, p=0.787). Although there was no difference in maximal sensory block level among the groups, three patients in the IP group, and two patients in the IS group failed to reach a T4 sensory block, whereas, none of the patients in the HP or HS groups failed to reach a T4 sensory block. Eight patients required supplemental analgesia: one in the HS, four in the IP, and three in the IS group (P > 0.05). No difference in the modified Bromage scale score was detected among the groups (Table 3). However, most patients in HP or HS group had complete motor block at 20 min after spinal anesthesia, while about half of patients in IP or IS group had complete motor block at 20 min after spinal anesthesia.

The incidences of nausea, vomiting, and headache were similar among the four groups. Four patients in each group had nausea but none vomited. In addition, one patient in HP group, one patient in HS group, two patients in IP group and two patients in IN group developed headache. Each patient in IP group and IN group was transfused with packed red blood cells but no difference in total volume of fluid infused was detected among the groups. Neonatal outcomes were similar among the groups based on the Apgar score and umbilical arterial blood gases (Table 4).

Figure 1 Flow diagram of the intervention. Group HP, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; Group HS, intrathecal hyperbaric bupivacaine with normal saline infusion; Group IP, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; Group IS, intrathecal isobaric bupivacaine with normal saline infusion.

Figure 2 Serial changes in systolic blood pressure during 30 min after spinal anesthesia. Data points are mean and error bar as standard error. Statistically significant difference was observed at 30 min after spinal anesthesia (P=0.015). SBP in IP and IS group was higher than SBP in HS group. HP group, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; HS group, intrathecal hyperbaric bupivacaine with normal saline infusion; IP group, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; IS group, intrathecal isobaric bupivacaine with normal saline infusion.

* $P < 0.05$ HS vs IP and IS

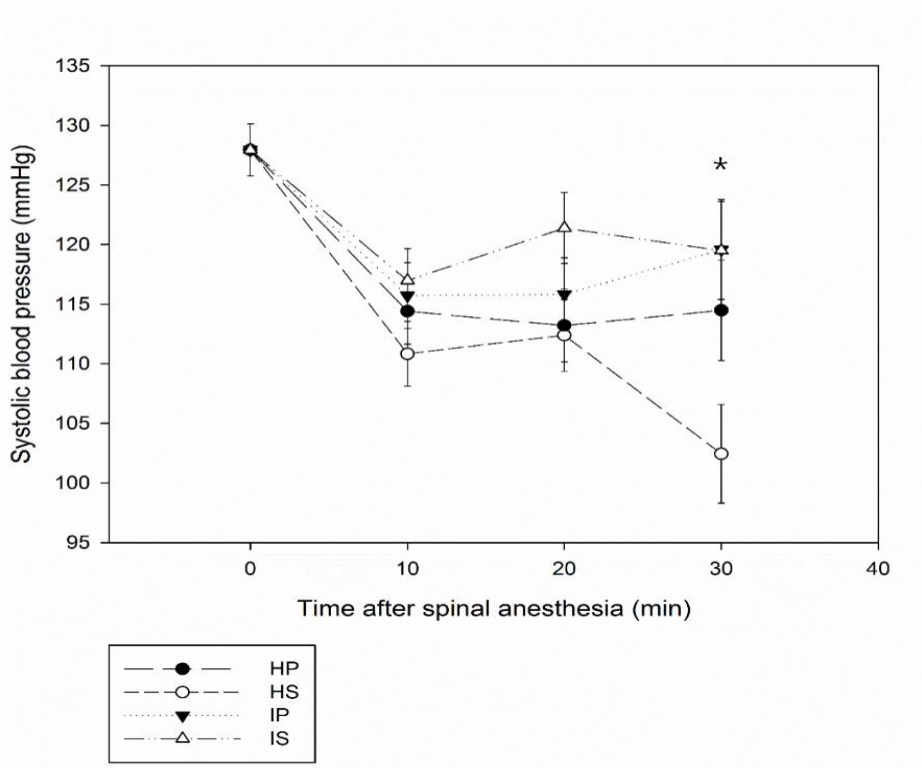

Table 1 Patient characteristics

	HP (*n*=16)	**HS (*n*=17)**	**IP (*n*=16)**	**IS (*n*=17)**	**P value**
Gestational age, weeks	38(37-38)	38(37-39)	38(37-38)	38(38-39)	0.421
Age, years	33.94(2.02)	36.35(3.82)	33.25(4.43)	33.94(3.98)	0.088
Height, cm	162.78(3.11)	161.48(3.99)	159.18(7.08)	162.63(4.67)	0.149
Weight, kg	68.93(9.14)	71.11(11.38)	68.76(10.93)	74.86(13.93)	0.393
Body mass index, kg/m^2	26.02(3.42)	27.18(3.59)	27.18(4.11)	28.25(4.73)	0.471
Nullipara/Multipara,n	6/10	6/11	7/9	8/9	0.892
ASA (I/II)	14/2	12/5	13/3	16/1	0.306
HTN,n	0	2	1	1	0.571
Surgery duration, min	65.81(19.01)	66.65(18.08)	65.63(15.48)	61.88(13.50)	0.843
Anesthesia duration, min	97.50(21.13)	97.65(17.69)	105.31(17.65)	96.47(14.66)	0.474

Values are mean (SD) or number (%). HP group, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; HS group, intrathecal hyperbaric bupivacaine with normal saline infusion; IP group, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; IS group, intrathecal bupivacaine with normal saline infusion.

Table 2 Incidence of hypotension and number of intervention to treat hypotension

	HP (*n*=16)	**HS (*n*=17)**	**IP (*n*=16)**	**IS (*n*=17)**	**P value[a]**
Incidence of hypotension for 10 min, n	8(50.0%)	15(88.2%)*	7(43.8%)	9(47.1%)	0.039
Incidence of hypotension for 30 min, n	11(68.8%)	15(88.2%)	8(50.0%)	9(47.1%)	0.078
Total number of intervention to treat hypotension for 10 min, n	0.5(0.0-2.0)	1.0(1.0-3.0)	0.0(0.0-2.0)	1.0(0.0-2.5)	0.414
Total number of intervention to treat hypotension for 30 min, n	1.5(0.0-3.75)	3.0(2.0-6.5)	0.5(0.0-2.75)	1.0(0.0-4.0)	0.129

Values are mean (SD), median (IQR) or number (%). [a]P values refer to differences among the four groups. HP group, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; HS group, intrathecal hyperbaric bupivacaine with normal saline infusion; IP group, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; IS group, intrathecal bupivacaine with normal saline infusion.

*P=0.007 vs IP

Table 3 Spinal anesthesia quality

	HP (*n*=16)	**HS (*n*=17)**	**IP (*n*=16)**	**IS (*n*=17)**	***P* value**
Time for sensory block to reach T4, min	4(2.5-6)	5(3-7)	6(2.5-13.5)	3(2-5)	0.276
Failure to reach T4 block, n	0(0.0%)	0(0.0%)	3(18.8%)	2(11.8%)	0.079
Highest level of sensory block	T2(T2-T3)	T2(T2-T4)	T2(T1-T4)	T2(T1-T3)	0.101
Bromage's scale 20 min (I/II/III)	14/2/0	15/2/0	9/5/2	9/6/2	0.105
Bromage's scale 120 min (I/II/III/IV)	2/0/7/7	2/1/5/9	1/0/7/8	2/0/4/11	0.863
Rescue analgesics, n	0	1(5.9%)	4(25%)	3(17.6%)	0.114

Values are number or median (IQR). HP group, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; HS group, intrathecal hyperbaric bupivacaine with normal saline infusion; IP group, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; IS group, intrathecal bupivacaine with normal saline infusion.

Table 4 Neonatal outcomes

	HP (*n*=19)	**HS (*n*=20)**	**IP (*n*=17)**	**IS (*n*=20)**	**P value**
Apgar scores at 1 min	8(8-8)	8(8-8)	8(7-8)	8(8-9)	0.673
Apgar scores at 5 min	9(9-9.25)	9(9-10)	9(9-9)	9(9-10)	0.357
Umbilical arterial blood gases					
Fetal acidosis	0(0.00%)	1(5.00%)	1(5.88%)	2(10.00%)	0.733
pH	7.31(0.03)	7.31(0.03)	7.29(0.03)	7.30(0.03)	0.310
Pco_2 (mmHg)	54.09(4.81)	50.52(5.51)	53.64(6.79)	54.19(7.27)	0.113
Po_2 (mmHg)	20.10(19.15)	20.59(6.39)	19.65(4.55)	19.91(17.43)	0.628
Base exess mmol/L)	-1.09(1.36)	-1.68(1.61)	-1.78(1.37)	-1.23(1.33)	0.356

Values are mean (SD), median (IQR) or number (%).HP group, intrathecal hyperbaric bupivacaine with continuous phenylephrine infusion; HS group, intrathecal hyperbaric bupivacaine with normal saline infusion; IP group, intrathecal isobaric bupivacaine with continuous phenylephrine infusion; IS group, intrathecal bupivacaine with normal saline infusion.

DISCUSSION

This study showed that the decrease in SBP caused by spinal anesthesia can be attenuated by intrathecal isobaric bupivacaine without phenylephrine infusion. Use of intrathecal hyperbaric bupivacaine without intravenous phenylephrine infusion induced a significant decline in SBP after the intrathecal injection, whereas use of intrathecal isobaric bupivacaine prevented the decline in SBP, regardless of the phenylephrine infusion. These results are consistent with previous studies suggesting that hyperbaric bupivacaine decreases SBP and DBP more than isobaric bupivacaine.[13, 15] However, those studies were performed in non-obstetric patients. Increased sensitivity to local anesthetics may result in hemodynamic changes in obstetric patients.[16] This is the first study to demonstrate a hemodynamic benefit of isobaric bupivacaine by comparing BP in obstetric parturient patients. In this study, it was observed that maternal SBP did not increase in IP groups when compared to IS group. That is, phenylephrine infusion did not lead to hypertension when isobaric bupivacaine was injected. It can be explained by the infusion rate. According to the previous study,[17] there was no difference in the incidence of hypertension between the patients who received phenylephrine infusion at 25 μg/min and the patients who received no phenylephrine. A rate of 25 μg/min is equivalent to the rate of 0.4 μg/kg/min which was employed in this study. Higher infusion rate may result in different consequences.

Although isobaric bupivacaine attenuated the decline in SBP at 30 min, there was no difference in the incidence of hypotension for 30 min. Otherwise, although there was no difference in SBP at 10 min among the four groups, the incidence of hypotension for 10 min was significantly different among the four groups. Despite rapid onset of phenylephrine, it is inferred that the effect of phenylephrine which was administered by bolus could be delayed. Likewise, constant interventions to treat hypotension could lead to insignificant incidence of hypotension for 30 min even though there was significant difference in SBP at 30 min among the four groups. Our results are consistent with some studies which reported no differences in the incidence of hypotension between isobaric and hyperbaric bupivacaine group.[18, 19] Those studies compared ephedrine doses which was administered to treat hypotension. However, it was unclear when ephedrine was injected in one study,[18] and 15 mg of prophylactic ephedrine was injected immediately after spinal anesthesia in the other study.[19] No study has compared the incidence of hypotension between isobaric and hyperbaric bupivacaine with phenylephrine. However, the definition of hypotension varies among studies and may influence the incidence.[3] Even subtle changes of the definition cause the incidences of hypotension varied between 7.4% and 74.1%. We used one of the most frequent definitions, which is a decrease below 80% baseline. Different definition of hypotension may lead to different outcomes.

Non-pharmacological methods were used initially to maintain maternal hemodynamics because vasopressors were believed to be detrimental to uteroplacental circulation.[20] However, non-pharmacological methods, such as augmenting blood

volume, may not completely prevent hypotension.[21, 22] In addition, most other methods, such as leg wrapping or a right pelvic wedge, are inconvenient and unreliable.[7] Therefore, pharmacological intervention is required to maintain stable hemodynamics. Although, it has been suggested that phenylephrine be used to prevent maternal hypotension and fetal acidosis,[8, 9, 23] the optimal regimen remains controversial. As most studies supporting the effect of phenylephrine on hemodynamics were performed with hyperbaric bupivacaine,[8, 10, 24] the efficacy of phenylephrine and intrathecal isobaric bupivacaine has not been determined. The results of our study suggest that isobaric bupivacaine preserves hemodynamic stability regardless of the use of phenylephrine.

It appears that the baricity of anesthetic solution has no effect on the onset of sensory or motor block. It remains controversial whether the characteristics of anesthesia are influenced by the baricity of the anesthetic solution. Several studies have reported similar onset time of hyperbaric bupivacaine and isobaric bupivacaine[25, 26] whereas a recent meta-analysis reported that a sufficient block was acquired more rapidly with hyperbaric bupivacaine when compared to isobaric bupivacaine.[27] In this study, the onset time was similar among the four groups. However, three patients in IP group and two patients in IS group failed to achieve a T4 sensory dermatome block whereas none in HP or HS group failed to achieve a T4 sensory dermatome block. Also onset times of isobaric bupivacaine ranged from 1 to 25 min even though its median value was 4.5 min which is similar to hyperbaric bupivacaine groups. We postulated that low concentrated solutions can be diffused more freely in cerebrospinal fluid, it would make isobaric bupivacaine

unpredictable. It is in close agreement with the data of study examining the clinical efficacy of a 0.5% bupivacaine.[28] The study observed that there was a large variability in onset time ranging from 2 to 10 min. Assessment of the block depends on subjective perception and modality. Three modalities, namely, cold, pinprick, and touch, are commonly used to assess block height, but no consistent association has been found between block heights assessed by modality.[29] Many studies have suggested that isobaric anesthetics resulted in an insufficient block because hyperbaric anesthetics diffuse to more cephalic segments due to gravity-dependent effects.[30] In this study, there were no significantly differences in spinal anesthesia quality among the four groups, but four patients in IP group and 3 patients in IS group required rescue analgesics whereas only one patient in HS group required supplement analgesics. Furthermore, most patients in HP or HS group could not move their feet at 20 min after spinal anesthesia, while about half of patients in IP or IS groups could move their feet.

This study had several limitations. First, there was a relatively small sample size for the analysis. Sufficiently high power to detect significance can be generated by a large sample size. Second, we selected different types of solution. Marcaine Heavy® was the hyperbaric bupivacaine and Chirocaine® was used as the isobaric bupivacaine. Identical local anesthetics with different baricity should have been used to derive a more meaningful conclusion. However, we have no isobaric Marcaine® or hyperbaric Chirocaine® at out institution, and manufacturing bupivacaine is complex and error-prone. Lastly, bupivacaine was injected at the L3-:L4 or L4-L5 interspace depending on the

anesthesiologist's preference, a technical reason or due to anatomical differences among patients. However the site of needle puncture might affect hemodynamics, onset time of spinal anesthesia and the block height.

In summary, this study demonstrated that hyperbaric bupivacaine without phenylephrine infusion decreased SBP, whereas isobaric bupivacaine maintained SBP without phenylephrine infusion. Therefore, isobaric bupivacaine can be used for stable maternal hemodynamics without phenylephrine infusion during cesarean delivery.

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국문 초록

서론: 제왕절개술을 위한 척추마취에서 고비중 부피바케인이 널리 사용되고 있다. 저혈압은 척추 마취 후 발생하는 흔한 합병증 중의 하나로, 산모의 저혈압을 예방하기 위해 페닐에프린의 지속적 정주요법을 사용한다. 등비중 부피바케인은 고비중 부피바케인에 비해 혈역학적으로 안정하다는 연구결과가 보고된 바 있다. 따라서 본 연구에서는 제왕절개술을 위한 척추마취에서 등비중 부피바케인을 사용하는 것이 페닐에프린의 지속정주 없이 산모의 혈역학을 안정적으로 유지할 수 있는지 알아보고자 한다.

방법: 본 연구는 단일 연구기관, 무작위 대조, 이중 맹검 연구로서 척추마취하에 제왕절개술을 받는 산모 66 명을 대상으로 하였다. 환자는 무작위로 네 그룹으로 나뉘었고, 배정된 군에 따라 고비중 혹은 등비중 부피바케인 10mg을 이용하여 척추마취를 시행하였고 페닐에프린 혹은 생리식염수를 지속정주하였다 .마취를 시행하기 전, 혈압을 3 번 측정하여 기준치를 산정하였고 태반이 만출되기 전까지는 1 분간격으로, 태반이 만출된 이후 수술 종료 까지 2.5 분간격으로 혈압을 측정하였다. 저혈압은 수축기 혈압이 기준치의 20% 이상 감소하였을 때로 정의하여 저혈압이 발생하였을 경우 페닐에프린 100

μg 을 추가 정주하였다. 척추마취 시행 10 분, 20 분 30 분 후의 수축기 혈압과 30 분 동안의 저혈압 발생빈도를 기록하였다.

결과: 척추마취 시행 후 30 분의 수축기 혈압은 고비중을 사용하고 페닐에프린을 지속정주하지 않은 군이 등비중을 사용하고 페닐에프린 혹은 생리식염수를 정주한 군보다 유의하게 낮았다 (102.43 ± 4.14 vs 119 ± 4.20 and 119 ± 4.09, p = 0.005 and 0.005). 고비중을 사용하고 페닐에프린을 지속정주 하지 않은 군이 등비중을 사용하고 페닐에프린을 지속정주한 군보다 척추마취 후 10 분동안 저혈압 발생빈도가 유의하게 높았다 (88.2% vs 43.8%, p=0.007). 마취의 질적측면, 부작용, 신생아 점수등은 네 그룹간의 유의한 차이는 보이지 않았다.

결론: 등비중 부피바케인은 고비중 부피바케인에 비해 페닐에프린의 지속정주 없이도 혈역학을 안정적으로 유지할 수 있었다.

주요어: 비중, 부피바케인, 페닐에프린, 혈역학, 산모, 제왕절개, 척추마취

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